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MODIFICATION TO THE EXISTING U.S. ARMY SOFTWARE MICRO-RESOURCE --ETC(U)
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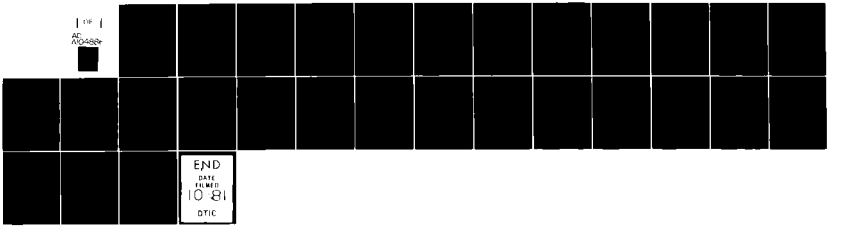

AD A104886

"Modification to the Existing U.S. Army Software
Micro-Resource Estimation Procedure"

Contract DAAG 29-76-D-0100
Delivery Order 1287

For: Battelle Columbus Laboratories
Columbus, OH 43201

U.S. Army Institute for Research in Management
Information and Computer Science
Atlanta, Georgia 30332

FINAL REPORT

FOR: Battelle Columbus Laboratorie , Columbus, Ohio 43201

U.S. Institute for Research in Management
Information and Computer Science
Atlanta, Georgia 30332

Contract DAAG29-76-D-0100, Delivery Order 1287

TITLE: Modification to the Existing U.S. Army Software Micro-Resource Estimation Procedure

CONDUCTED BY: The School of Industrial and Systems Engineering
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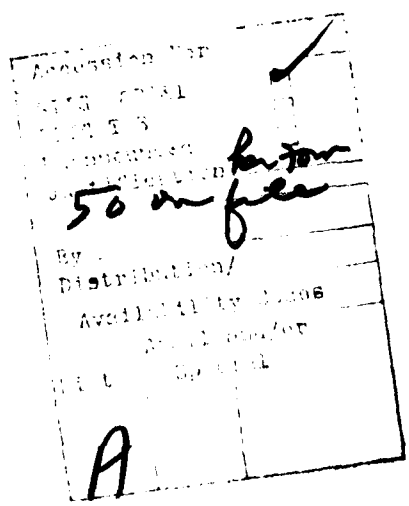
Principal Investigator
Nov[redacted]1979



COMPUTER SYSTEM COMMAND

I. Background

The U.S. Army Institute for Research in Management Information and Computer Science (AIRMICS) entered into an agreement with the Georgia Tech Research Institute to fund a three month study titled, "Modification to Existing U.S. Army Software Micro-Resource Estimation Procedure". The study was conducted by Dr. Gerald J. Thuesen of the School of Industrial and Systems Engineering.

The setting for the study was the Computer Systems Command Support Group at Fort Lee, Virginia. (Support Group Lee) This command is within the U.S. Army Computer Systems Command which is responsible for the design, development and maintenance of management informations systems for over 200 military computer installations throughout the world.

Although organizationally separated, Support Group Lee is responsible for all maintenance of computer programs utilized by the Army Logistics Command also located at Fort Lee. The Army Logistics command refered to as a proponent agency prepares and submitts requests for program modifications to Support Group Lee. These requests are then routed to the division within Support Group Lee that is responsible for the programs affected.

To manage the change request from its receipt to final disposition it is necessary to estimate the resources that will be required to make the modifications requested. These estimates are usually prepared by the systems analyst or programmer who is familiar with the affected programs. Then the individual requests are grouped into System Change Packages (SCP's) with the approval of the proponent agencies. These SCP's are then the basis for commitments to the proponent agency regarding the time to completion. Also,

the SCP's form the basis for controlling and managing within Support Group Lee the resources necessary to perform the modifications.

The present method of resource estimation for the individual change request uses a micro-estimating technique that is embodied in the USACSC Form 50. (See Appendix A) The procedure utilized on this form requires numerous decisions regarding program complexity, the quality and availability of resources, knowledge required and the extent of the change. In addition, predetermined factors are used to account for indirect time related to the task. The result of selecting various values for each element on the form and combining these elements as described yields an estimate in man-days of the time to do the job. This estimate provides the elapsed time to accomplish the job rather than the direct time that would be expended executing the actual work.

Raven Systems and Research, Inc. was assigned the task to study the current estimating procedure based on the Form 50. Their conclusions and recommendations are included in their August 1979 report to AIRMICS (2). Essentially, the report discusses how the users view Form 50 and its resulting estimates, the accuracy of those estimates, and the difficulties of varifying those estimates.

Since the interval of the Raven Systems study overlapped the initiation of this study, Dr. Thuesen worked directly with the participants in the Raven System study. Although most of the data gathering had been accomplished, Dr. Thuesen and Dr. Ronald Askin participated in the design of the modified Form 50 proposed in the Raven Systems report. Although the basic approach was not changed, the procedures were considerably simplified to at least reduce the computational errors being introduced by the more complex Form 50.

The task of this study is to utilize the data gathered by Raven Systems and to develop an improved method of micro-resource estimation. That is, we would investigate whether an improved estimating methodology could be developed so that better resource planning and control would be possible. This new methodology would hopefully replace the present approach represented by Form 50 and expand the application of the estimates. A major difficulty pointed out by the Raven Systems study was the inability to elicit the actual man-days to perform a particular SCR. Therefore, any approach utilized in this study could not be based on any comparisons of actual versus estimated data. Therefore, this study not only proposes a new method of estimating, but also a procedure for validating the new approach that is suggested. This validation would compare on a statistical basis actual time with estimated time.

II. Procedures

The procedures utilized in this study included two phases. The first phase is primarily concerned with understanding how Support Group Lee functions and familiarization with the literature that seemed applicable to the problem of estimating resources. Dr. Thuesen and Dr. Askin attended meetings within AIRMICS at Georgia Tech for orientation and considerable time was spent with James Gantt of AIRMICS in discussing how Support Group Lee operated. Then, as Raven Systems finished their interviews, we held approximately five meetings with their personnel to get a more detailed description of how the micro-estimating procedure was presently operating.

At the same time, Dr. Thuesen and Dr. Askin were investigating the literature with regard to techniques that would be applicable to the micro-estimating problem faced by Support Group Lee. Because almost all the workload at Support Group Lee consists of modification of computer

programs rather than program development, an attempt was made to find existing methods that would be applicable. One document that describes in detail the present methodologies for resource estimation is a 1978 report by H. M. Wadsworth (3). Unfortunately, none of the methods discussed in this report seemed applicable to the resource estimation of computer program maintenance.

The second phase of this study was focused on developing a new approach for micro-estimating and determining the method of validation that should be followed. This phase required two trips for interviews with personnel in Support Group Lee. The first trip was used to determine whether the modified Form 50 proposed by Raven Systems would be sufficient. After the interviews, it was clear that an approach that estimated direct man-days rather than elapsed man-days would be more useful for control and management of the SCP's.

The second trip was utilized to elicit suggestions and comments concerning the new approach that had been developed since our first contact with Support Group Lee. Both project leaders and programmers were shown two different forms based on the same basic approach. The form in Appendix B, which was finally adopted, requires considerably less detailed estimating than the form shown in Appendix C. The more detailed procedure shown in Appendix C was generally rejected by those who would have been responsible for executing the estimating procedure. The concensus opinion was that it is not realistic to separate the various inputs into such small elements. Thus, no improvement in the final estimate would be achieved by making the additional effort to work with the larger number of elements.

In addition, discussions concerning the best approach for validating the new estimating procedure were had with those who would be directly involved in any new estimating methodology. It was concluded that the basic estimating unit should be each system change request. (SCR) By recording the estimates made for each SCR before the work is performed and utilizing the project management system (PMS) to record the actual effort expended, data for validation would be available for the first time.

The data resulting from this data collection activity would then be analyzed to test for significant statistical deviations between the actual and estimated values. The statistical tests to be applied have been determined as part of this study and they will be discussed in detail.

The final task in the second phase of this investigation will be the preparation of the final report.

III. Analysis

Before the initial trip to interview personnel for this study, Dr. Thuesen and Dr. Askin held four lengthy sessions with Robert Barrier and Gaye Stewart of Raven Systems. The purpose of these meetings were to gather information pertinent to the study to be undertaken. Since it was known that the final report to be prepared by Raven Systems would not be completed by the time our study was initiated, we worked informally to understand the status of the micro-estimation procedure that was currently in operation at Support Group Lee.

A number of important issues were identified and it is these issues that became the basis for our proposed solution to the micro-estimating process. It became evident that any micro-estimating procedure must

provide information that was meaningful for aggregating the change requests into the System Change Packages. (SCP) This process described as a "scrub" session allowed the proponent agency and the personnel at Support Group Lee to prioritize the change requests which were to be included in the new SCP's. At this time, the estimates of man-days determined by the Form 50's are utilized to provide some indication of the resources that would be required by Support Group Lee to accomplish a particular job. The estimates that were used in this process were sometimes modifications of the Net Development Time as shown on the Form 50. These modifications were based on a reduction of the Net Development Time obtained by multiplying by factors of 0.4 to 0.5. These factors based on the experience of team leaders at Support Group Lee, gave us a strong indication that those team leaders who, according to the Raven Systems people, were more sophisticated in their management techniques realized that the Form 50 estimate was not accurate.

Because we had no data on which to verify these opinions, we established the position that team leader experience will approximate the actual outcome with a good degree of confidence. This conclusion is based on the consulting experience of Dr. Thuesen, who has observed numerous instances where approximate methods based on experience usually provides results close to what might have been achieved with more systematic analysis. (i.e. Common sense tempered with experience leads to near optimal solutions)

Based on these observations, it was concluded that the Form 50, which provided total elapse time, was not the appropriate information for establishing change request priorities in the "scrub" session. It was the direct hours associated with the change requests that would be more useful in this planning activity.

Once an SCP is assembled, the other important function that is dependent on good micro-estimating is project control or project management. The SCP becomes the basic unit for determining milestones and final delivery dates. According to the Raven Systems people, more preestablished milestones for SCR's are missed than are achieved. Some of these milestones have been missed by more than 200%. It was our impression based on conversations with Raven Systems personnel and Support Group Lee personnel, that this inability to meet stated deadlines was the most serious problem faced.

Accepting this premise then caused us to examine how improved control of the SCP's could be accomplished. In our discussions with Raven Systems and Support Group Lee, it was recognized that the problem of project control had many facets; one of which was the lack of accurate time estimates for the SCP's. However, the most serious problem seemed to be related to the wide variety or lack of methods used by the various project leaders for project control and resource planning. Although the Project Management System (PMS) is available and encouragement is given by upper management for its use, only a few individuals were, in fact, using this system. Since PMS is designed with great user flexibility, each user has tailored his own individual reporting scheme and what use is occuring is non-standardized.

Because PMS is a powerful management tool and because an even more useful Decision Support System is currently under development by AIRMICS, we concluded that any micro-resource estimating technique that is developed should provide the information in a form that increases the efficiency of these management tools. The data form which allows greatest utilization of PMS is to input direct man-days for task completion. Direct man-days

represent the estimate of actual hours to be spent on Review and Analysis, Design, Communication, Coding, Level I testing and Documentation. Additional data regarding the future availability of resources due to planned vacations, scheduled leaves, and other anticipated manpower-reductions are then input directly into PMS. This approach allows each unit to plan more realisticly according to their specific resource availabilities.

The approach on which the Form 50 is based provides total elapsed time that is determined by using constant factors for the estimation of resources required by the non-direct activities. As a result, each unit has less ability to recognize their own peculiarities regarding their non-direct resource requirements. In addition, there was no indication that the Form 50 methodology would provide resonable estimates of the direct time. Therefore, it was concluded that a new method needed to be developed that would focus on micro-resources estimation of direct manpower requirements.

IV. Results

Working from the basic premise that the appropriate information to be provided by any micro-estimating procedure, should be in terms of direct effort expended, an entirely new estimating procedure was developed. This procedure requires that estimates be made in such a manner that each individual contribution to the direct work effort performed be included. Because the estimates are to be in direct man-days, the estimates for each of the component activities required to complete the SCR will be additive. Thus, a rather simple arithmetic procedure has evolved which will be useful in the estimation of resource requirements for both the SCR's and the SCP's.

A. Estimating the SCR

Because the most basic work task is the program affected in each system change request (SCR), it was decided that this basic unit should be the basis for micro-resource estimating. With the possibility of one or more individuals being directly involved in the work activity, the decision was made that a direct man-day estimate, for each individual be recorded. Thus, if the nature of the work indicates that a systems analyst and two programmers will be involved, three separate estimates are to be made. Each estimate should be produced by each of the individuals in light of the tasks that each anticipates being required to perform. If this level of knowledge about who is to perform what specific tasks is not available, then a single estimate will be made. The general rule is that as many estimates will be made for each program within a SCR as there are individuals who are actually required to make inputs regarding their estimated functional involvement in performing work on that particular program.

The form presented in Appendix B will be the mechanism for recording the estimates of the individuals involved. Thus, not only must the system, SCR number, and program affected be identified, but each contributor to the overall estimate must also be known.

After considerable study and review by personnel at Support Group Lee, six important categories of work effort were identified. These six categories encompass the significantly different types of work activities that are usually associated with a systems change request (SCR). Because it was recognized that the individuals that impact on a SCR may be performing different functions, it is important that each category be interpreted with

respect to each individuals contribution. That is, a systems analyst may view the work effort required for the Review and Analysis category quite differently than a programmer would view the same category. The systems analyst may be reviewing the system of programs being affected while the programmer would be spending his review effort in understanding how the specific program for which he is responsible would be changed.

B. Estimating Categories

The six estimating categories on which the proposed micro-resource estimating procedure is based are:

Review and Analysis

Design

Communication

Coding

Level I Testing

Documentation

Each individual involved in the estimating procedure should make estimates only for those categories in which a direct contribution to the completion of the task will be made. For each category estimated by an individual, a single value representing the anticipated direct man-days require will be recorded. If there are categories for which an individual has no involvement, his estimate should be left blank for that category. It is anticipated that a systems analyst will not normally contribute in the Coding category, so no entry should be made.

It should be pointed out that activities such as Level II Testing, Level III Testing, Environmental Test and Field Validation are considering outside the proposed estimating procedure. Because these activities are generally handled differently and they are much more dependent on availability of computer time, it is believed that a different approach must be

followed in order to develop accurate estimates for these activities. However, it is important that accurate estimates of these activities need to be available if sound planning and control is to be achieved at Support Group Lee.

1. Review and Analysis

In general, this activity represents all the preparatory work that is necessary before any decision regarding implementation of the change request can be made. For the System Anslyst, this would include the effort spent co-ordinating and communicating with the proponent agency to insure there is an accurate understanding of the request. In addition, time spent studying the relation of the change request to the system of programs affected would be included in this category.

On the other hand, this category represents for the programmer the effort to be expended in understanding the program files and logic to be affected by the change request. This estimate should include studying program listings, locating documentation, recording the nature of the change request, and understanding the scope of the problem.

2. Design

This category is concerned with the effort that is to be expended in translating the change request into specific remedies that will insure successful completion of the task. Primarily, this category will recognize the time involved in synthesis, and the development of specific change specifications. It is anticipated that both system analysts and programmers will be involved in this type of activity. The systems analyst will be involved with design regarding how the change request affects the system of programs while the programmer will be concerned with how the change request affects his particular program.

3. Communication

The effort that arises from the interaction between the system analyst and programmer to assure that the changes to each of the system parts will lead to the overall objective of the change request will be recorded as communication. This activities will include both written and verbal communication. When this type of activity occurs, the systems analyst should estimate his involvement (he may be involved with a number of programmers for a particular SCR) and the programmer will estimate his effort in this activity.

4. Coding

Under this category is recorded all the effort expended by the programmer to translate the change specifications into coded logic. Given the change specifications, what coding, file manipulation, and other programming activities are necessary to produce a source deck that is ready for testing.

5. Level I Testing

This category reflects all the effort that is required to test the program that has been modified to satisfy a change request so that the program will be ready for Level II Testing. The effort recorded should reflect activities which include compilation, development of test data, analysis of test results and corrections. It is important for this category that only direct effort expended by considered so that delays due to machine availability are not part of the estimate. Machine dependent delays should be considered as indirect effort that is required to satisfy the change request.

6. Documentation

Any documentation effort associated with a completed change request will be recorded here. Documentation includes any changes to operating or system manuals and any documentation associated with changes in program logic. Again, only the direct effort expended by the system analysis or programmer should be considered here.

In addition to the information that appears on the front of the Direct Man-Day Estimating Form, our discussions with Support Group Lee personnel revealed that some written description of the nature of the changes that were the basis for the estimate would be extremely useful. Because the original estimate for the SCR is made months in advance of the inclusion of that SCR in a SCP, it was usual that the person making the estimate was not the same person actually implementing the change request. All personnel we questioned insisted that if the person making the original estimate would record in writing a description of the program changes necessary to satisfy the change request, much greater understanding of the estimates would be possible. Also, the written record would provide a continuity so that the person who must actually implement the change request will not have to begin his analysis from scratch.

This narrative description of anticipated changes includes a place to list the files that would be affected by the SCR. Again, this information is intended to help validate the estimate and to provide continuity to the estimating process.

C. Estimating the Systems Change Package (SCP)

The individual estimates on the SCR's are intended to be the basis for determining delivery times for a SCP. It is anticipated that following the "scrub" session milestone estimates would be developed by combining the direct man-day estimates for the SCR's contained in a SCP with the indirect man-days estimated for all personnel activities not directly attributable to the change request. These estimates are then input to the Project Management System (PMS) so that the total resources can be scheduled and reasonable milestones for completion of system change packages can be fixed. This process should be relatively straight forward as the direct

man-day estimates resulting for the new form will be additive with the indirect man-day estimates.

D. Testing the Validity of Estimating Technique

The validation of the micro-resource estimating technique proposed in this study should have two distinct benefits. First, the estimates made prior to the initiation of the work can be statistically compared with the actual effort recorded for that work. For each of these categories a statistical comparison will be made to see how well each of these type of estimates can be made. Also, the total man-days estimated will be compared with the actual total effort expended so that the process of summing the categories to find aggregate estimates can be validated.

The second important effect of recording estimated and actual effort expended is the increased awareness that will be engendered in the Support Group Lee personnel. This awareness should encourage more serious consideration of the individual's role in making reliable estimates when using the proposed procedure. Many of the persons interviewed felt that this would be one of the most positive outcomes of this study.

1. Test Procedures

T_1 shall represent the time (or the form initiated at that time) at which an SCR is first obtained from the proponent agency.

T_2 shall represent the time (or the form recorded at that time) immediately before the scrub session. (It is assumed that at T_2 the person or persons who will be working on the SCR can be identified)

T_3 shall represent the time (or data recorded) just after completion of the work on the SCR. (Actually, as categories of work are completed, the effort will be recorded and input to PMS)

2. Data Collection

Two teams, SAAS LVL I headed by Mr. R. A. DeLong and A(-)/ACS Team by Mr. I. T. Putton, have been selected by management at Support Group Lee to provide the test environment for the proposed micro-estimating procedure. Both groups will be utilized to provide estimated and actual data and it is intended that this data be accumulated for approximately one year. This study period will allow for the inclusion of 3 to 4 completed SCP's for each team. Based on the normal size of an SCP, it is anticipated that 150 to 250 separate estimates will be required providing a solid data base.

Data Collection Steps

a. At time T_1 any involved systems analyst and programmer will fill out separate estimating forms for each program affected by the SCR. These will then be filed together as a combined estimate.

b. At time T_2 the systems analyst and any programmers who are actually responsible for implementing the SCR will fill out separate estimates on the form. There will be a form required for each program affected by the SCR. These estimates will be filed together and the sum of the individual estimates will represent the total direct time estimated for the SCR.

c. As soon as the actual work commences on the SCR, the actual direct time expended in each of the six categories will be recorded daily. These daily records will then be the basis for weekly reporting of actual effort expended. By utilizing the Project Management System (PMS) the weekly totals of actual direct man-days allocated to each of the six categories will be available for analysis. (It is important that the same format and reporting categories be used in PMS by all participants

in the study) At time T_3 comparisons of actual effort versus estimated effort will be made.

3. Test of Direct-Man Day Estimating Form

By having estimates at T_1 and T_2 and actual values at T_3, there are two primary premises to test. Comparing actual effort expended to the estimates made at T_2 we have a test of estimating proficiency in the most favorable of circumstances. That is, the individuals who are actually assigned to do the work will be making the estimate immediately prior to starting the job, hence the same individual will be making the estimate and doing the work. It is assumed that an individual can best estimate the effort he must expend for satisfactory completion of the job. We believe that the individual knows his own capabilities better than someone else.

The second premise to test is whether estimates made at T_1 are reliable estimates of the actual effort that is expended. In this case, those who are making the estimates are not necessarily those who will be doing the actual work. Also, these initial estimates usually occur two to six months before the work actually begins and, therefore, there may not be a clear definition of the actual tasks that must be accomplished.

V. Statistical Tests

A. Group 1

Test the hypothesis that the mean of each category estimated at T_2 is equal to the mean of the actual values at T_3. N_1 is the number of SCR's completed by Group 1. The statistical test use is a paired t test (1, p242-246)

Let x_{ij} be the estimated direct man-days for SCR i and cateogry j

$(i = 1,2,\ldots,n_1)(j = 1,2,\ldots,6)$

Let y_{ij} be the actual direct man-days for SCR i and category j $(i = 1,2,\ldots,n_1)(j = 1,2,\ldots,6)$.

1. Calculate $d_{ij} = x_{ij} - y_{ij}$ for each SCR i.

2. Calculate $S_j^2 = \left(\frac{1}{n-1}\right)\left[\sum_{i=1}^{n} d_{ij}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} d_{ij}\right)^2\right]$ for $j = 1,2,\ldots,6$

3. Calculate $t_{j,0} = \dfrac{\dfrac{\sum_{i=1}^{n} d_{ij}}{n}}{\left(\dfrac{S_j^2}{n}\right)^{\frac{1}{2}}}$

4. Compare to a t distributed random variable with n-1 degrees of freedom (1, p.603). If $(t_{j,0})$too large, reject the hypothesis that the mean of the total estimated direct man-days is not equal to the mean of the total actual effort expended, for element j. That is, the new estimating technique is not providing reliable estimates of the total effort expended.

B. Group 2

Repeat all tests on Group 2 data that were performed on Group 1. Let n_2 be the number of SCR's completed by Group 2.

C. Group 1 and Group 2

Combine the Group 1 and Group 2 data for an overall test of the effectiveness of the estimating technique.

If $d_i' = \sum_{j=1}^{6} d_{ij}$ the data format for groups 1 and 2 will be

$$\underbrace{d_1', d_2' \ldots d_{n_1}'}_{\text{Group 1}} \quad \underbrace{d_1', d_2' \ldots d_{n_2}'}_{\text{Group 2}}$$

d_i' is the <u>total</u> estimated direct-man days for the ith SCR within a group.

1. Calculate $\tilde{d}_i = \underbrace{d_1' + d_2' + \ldots + d_{n_1}'}_{\text{Group 1}} + \underbrace{d_1' + d_2' \ldots + d_{n_2}'}_{\text{Group 2}}$

2. Calculate $S^2 = \left(\frac{1}{n_1+n_2-1}\right)\left[\sum_{i=1}^{n_1+n_2} d_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n_1+n_2} d_i\right)^2\right]$

3. Calculate $t_0 = \dfrac{\sum_{i=1}^{n_1+n_2} d_i}{\left(\dfrac{S^2}{n_1+n_2}\right)^{\frac{1}{2}}}$

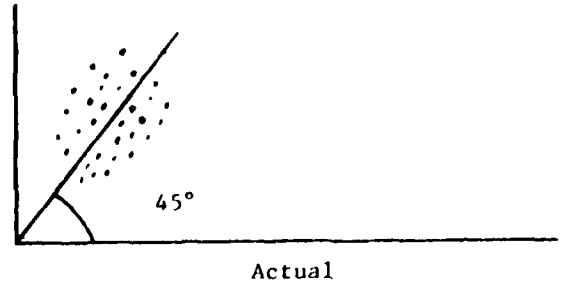
4. Compare to a t distributed random variable with $n_1 + n_2 - 1$ degrees of freedom. If $|t_0|$ too large, reject the hypothesis that the mean of the total estimated effort for both groups is equal to the mean of the total actual effort expended by the two groups.

D. *Comparison*

To test the effectiveness of providing reliable estimates by estimating at T_1, compare the T_1 data with the T_3 data. All the tests described in A, B, and C would be repeated for this different data set.

E. Scatter Diagram

An additional technique for investigating visually the relationship between the actual values and the estimated value can be accomplished through the use of a scatter diagram. That is, plot the estimated value for each data point against the actual value for that point. An example of a scatter diagram is shown below:



This technique is useful in providing insight regarding the bias associate with data where it has been shown statistically that the means are not equal with any statistical confidence.

VI. Conclusions

After having studied the data gathered by Raven Systems regarding the use of the existing Form 50, and having visited Support Group Lee and observed how they operate, the following recommendations are suggested. These recommendations are focused strictly on the task of micro-resource estimation:

1. Form 50, the existing mechanism for estimating resources expended, should be replaced by an estimating methodology based on the direct man-days required to accomplish the task. The new format for these estimates is presented in Appendix B.
2. Estimates should be made by the person or persons who will actually make the change immediately prior to the initiation of the work. If estimates must be made some time in advance, new estimates should be made just prior to undertaking the work;
3. The Project Management System should be utilized to track the direct and indirect effort associated with each System Change Request (SCR). This record keeping will ensure the availability of data so that improvements in the micro-estimating process will result.

4. Statistical verification of the new methodology will be accomplished by the study over the period of approximately one year of actual vs. estimated man-days required. Two teams of Support Group Lee, SAAS LVL I and A(-)/ACS, have been selected to provide as the test environment for the verification of the proposed procedures. This study will provide the first reliable data that should be the basis of any well constituted estimating procedure.

REFERENCES

1. Bowker, A. H., and Lieberman, G. J., Engineering Statistics, 2nd ed., 1972.

2. Raven Systems & Research, Inc., "Software Micro Resource Estimation Data Collection Study," Technical Paper Raven-TP-2, August 1979.

3. Wadsworth, H. M., Jr., "A Complete State-of-the-Art Analysis of Resource Estimating Methodologies," U.S. Army Institute for Research in Management Information and Computer Science, Atlanta, Georgia, 30332, October 1978.

IMPACT ESTIMATING

For use of this form, see USACSC-SGL Memo 18-1 (Chap 5); the proponent agency is USACSC Spt Op, Ft Lee (OAO)

SYSTEM _____ ESTIMATOR'S NAME(S) _____

SCR/PROGRAM _____ DATE _____

This form is to be used for impacting man-days effort required for implementation of the above SCR/program. Standard factors are shown below. This form is to be attached to USACSC Form 6.

SECTION I

	Number	X Factor		
1. INPUT FILE FORMATS AFFECTED BY THIS SCR				
a. Number of card files	_____	X 1 =	_____	
b. Number of tape files	_____	X 1 =	_____	
c. Number of disk files	_____	X 1 =	_____	TOTAL _____
2. OUTPUT FILE FORMATS AFFECTED BY THIS SCR				
a. Number of card files	_____	X 1 =	_____	
b. Number of tape files	_____	X 1 =	_____	
c. Number of disk files	_____	X 1 =	_____	
d. Number of report formats	_____	X 1 =	_____	TOTAL

3. PROGRAM FUNCTIONS. NOTE: This table reflects the number of programs which include functions affected by the SCR. (e.g., An SCR may affect an edit-validation function in each of 3 programs. Two are simple, one is complex. Enter:
a. Edit-validation 4 X 2 = 8 8 X 1 = 8 12 X 0 = 0)

	SIMPLE Factor X Pgms		COMPLEX Factor X Pgms		VERY COMPLEX Factor X Pgms	
a. Edit-validation	4 X ____ =	____	8 X ____ =	____	12 X ____ =	____
b. Sort/merge process	2 X ____ =	____	3 X ____ =	____	4 X ____ =	____
c. Internal data manipulation	2 X ____ =	____	3 X ____ =	____	4 X ____ =	____
d. File search	2 X ____ =	____	3 X ____ =	____	4 X ____ =	____
e. Table look-up (internal or external)	3 X ____ =	____	5 X ____ =	____	7 X ____ =	____
f. Calculations	3 X ____ =	____	5 X ____ =	____	7 X ____ =	____
g. Utilities or subroutines	2 X ____ =	____	3 X ____ =	____	4 X ____ =	____
h. Job Control languages	1 X ____ =	____	2 X ____ =	____	3 X ____ =	____
Subtotals		____		____		____
Total of Program Functions	____					

4. RESOURCES AVAILABLE FOR WORK ON THIS SCR

	Number	X Factor	
a. Lead Analyst (GS-13 Equivalent)	_____	X 0.75 =	_____
b. Senior Analyst (GS-12 Equivalent)	_____	X 1.25 =	_____
c. Journeyman Analyst (GS-11 Equivalent)	_____	X 1.75 =	_____
d. Analyst (GS-9 Equivalent)	_____	X 2.25 =	_____
e. Intern Analyst (GS-7 Equivalent)	_____	X 2.75 =	_____
f. Lead Programer (GS-13 Equivalent)	_____	X 0.75 =	_____
g. Senior Programer (GS-12 Equivalent)	_____	X 1.25 =	_____
h. Journeyman Programer (GS-11 Equivalent)	_____	X 1.75 =	_____
i. Programer (GS-9 Equivalent)	_____	X 2.25 =	_____
j. Intern Programer (GS-7 Equivalent)	_____	X 2.75 =	_____
No. people	_____	Sum	_____
Resource average = Sum ÷ Number people =			_____

5. JOB KNOWLEDGE REQUIRED FOR THIS SCR

	FACTOR
a. Limited	0.5
b. General	1.0
c. Detailed	1.5

_____

6. JOB KNOWLEDGE AVAILABLE FOR THIS SCR

	FACTOR
a. Limited	1.5
b. General	1.0
c. Detailed	0.5

_____

USACSC-FT LEE FORM 50
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7. PROGRAM TURN-AROUND TIME (Average)

	FACTOR
a. Effective IAP Usage	0.6
b. More than once per day	0.8
c. Once per day	1.0
d. Less than once per day	1.2

8. SYSTEM FACTOR

	FACTOR
a. Developmental	2
b. Major change	3
c. Major modification	4
d. Minor modification	5
e. Maintenance	6
f. Minor technical change	7
g. JCL change only	8

9. DOCUMENTATION CHANGES REQUIRED BY THIS SCR

Number of pages to be changed/added _____

10. COMPUTER TIME REQUIRED

Hours _____ *

SECTION II
NET DEVELOPMENT TIME

1. (1) Input Total _____ + (2) Output Total _____ + (3) Program Function Total _____ = (3a) Sub-Total _____ NOTE: If (3a) is zero, enter one.

2. Total from (3a) _____ X (4) Resources Average _____ X (5) Job Knowledge Required _____ X (6) Job Knowledge Available _____ X (7) Program Turn-around Factor _____ = (7a) Sub-total _____

3. Total from (7a) _____ X 2 ÷ (8) System Factor _____ = (9) Development Time _____ X (10) Other System Factor 1.8 X (11) Non-Project Factor (1.25 + 0.1) = 2.43 (12) Lost Time Factor _____ = (13) Net Development Time _____ man-days

Total of Column 13 is entered onto Line #1 of the SCR Estimate Summary and will be defined as Net Development Time on the SCR Estimate Summary.

SCR ESTIMATE SUMMARY

1. Net Development Time = _____ man days

a. Review and analysis	= NDT X 0.15 =	_____	X 8 =	_____	*
b. Design	= NDT X 0.20 =	_____	X 8 =	_____	*
c. Programing (including Level I testing)	= NDT X 0.35 =	_____	X 8 =	_____	*
d. Testing (including Level II & III testing)	= NDT X 0.25 =	_____	X 8 =	_____	*
e. Documentation (enter zero for none)	= NDT X 0.05 =	_____	X 8 =	_____	*

2. Total project man-days (sum of 1a-e above) TPMD = _____ man-days X 8 = _____ man-hours

* Enter these figures in the appropriate blocks of the Impact Analysis section of USACSC Form 6, (System Change Request)

DIRECT MAN HOUR ESTIMATING

DATE _____

SYSTEM _____ ESTIMATOR'S NAME _____

SCR NUMBER _____ PROGRAM _____

1. Review and Analysis _____ Man-hrs.

   (Includes research, clarifying change request, interacting with proponent agency)
   (i.e. What is to be done)

2. Design _____ Man-hrs.

   (Problem definition at program level, synthesis, develop change specification)
   (i.e. How it is done)

3. Communication _____ Man-hrs.

   (Interaction between programmer and systems analyst)

4. Coding _____ Man-hrs.

   (All coding activities to implement change specifications)

5. Level I Testing _____ Man-hrs.

   (Compilation, development of test data, analysis of test results and corrections)

   Estimated Number of Runs _____

6. Documentation _____ Man-hrs.

   (Any documentation required for completed change)

TOTAL _____ Man-hrs.

NARRATIVE

1. Programs Affected

_____ _____ _____ _____ _____

2. Files Affected

_____ _____ _____ _____ _____

3. Description of program changes on which this estimate is based.

DIRECT MAN HOUR ESTIMATING

DATE _____

SYSTEM _____ ESTIMATOR'S NAME _____

SCR NUMBER _____ PROGRAM _____

1. Review and Analysis

   Research _____ Man-hrs.

   Interacting with proponent agency _____ Man-hrs.

   TOTAL _____ Man-hrs.

2. Design

   Problem definition _____ Man-hrs.

   Synthesis _____ Man-hrs.

   Develop specification _____ Man-hrs.

   TOTAL _____ Man-hrs.

3. Communication TOTAL _____ Man-hrs.

4. Coding

	Program Complexity			Extent of Change				
	Simple	Normal	Complex	Simple	Minor Mod.	Major Mod.	Dev.	
a. I/O Formats	1	2	3	1	2	3	4	_____ Man-hrs.
b. Edit/Valid.	1	2	3	1	2	3	4	_____ Man-hrs.
c. Internal Processing	1	2	3	1	2	3	4	_____ Man-hrs.
d. Internal Data Manipulation	1	2	3	1	2	3	4	_____ Man-hrs.
e. Other								_____ Man-hrs.

   TOTAL _____ Man-hrs.

5. Level I Testing

   a. Compilation/Verication _____ Man-hrs.

   b. Development of test data _____ Man-hrs.

   c. Validation of test results _____ Man-hrs.

   TOTAL _____ Man-hrs.

6. Documentation

   a. User Manual _____ Man-hrs.

   b. Operations & Scheduling Manual _____ Man-hrs.

   c. Program logic documentation _____ Man-hrs.

   TOTAL _____ Man-hrs.

TOTAL MAN-HRS. TO COMPLETE CHANGE _____ Man-hrs.

NARRATIVE

1. Programs Affected

2. Files Affected

3. Description of program changes on which this estimate is based.

END

DATE
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